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REVISION A

ANALYSIS TECHNIQUES FOR A-7D AIRCRAFT IN-FLIGHT RECORDER DATA

JUNE 1980

AEROSPACE STRUCTURES
INFORMATION AND ANALYSIS CENTER

OPERATED FOR THE AIRFORCE FLIGHT DYNAMICS LABORATORY
BY ANAMET LABORATORIES, INC.

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This report summarizes the planned method of analysis of the A7D flight loads data collected by multi-channel recorders. The verified results will then be used to produce exceedance curves and histograms. This work was the preliminary step in a complete analysis of data to be conducted at a later date.

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TABLE OF CONTENTS

LIST OF TABLES

I. INTRODUCTION

This effort was conducted to study the techniques necessary to analyze A-7D flight loads data collected at Davis-Monthan AFB, Arizona, Selfridge Air National Guard (ANG) Base, Michigan, and Toledo ANG Station, Ohio, by Mr. David L. Banaszak, AFWAL/FIBG, using multi-channel flight loads recorders. Three axis accelerations, three axis rotations, altitude, and airspeed were recorded on tape magazines as shown in Table 1. These magazines were then sent to Wright-Patterson AFB where the Structural Vibration Branch (FIBG) of the Flight Dynamics Laboratory condensed the raw data on standard 9-track computer tapes. At this point the Aerospace Structures Information and Analysis Center (ASIAC) was contacted to examine the data and to consider reducing this data into a form suitable for presentation in a technical report.

TABLE 1

OUTPUT DATA SYMBOL AND UNITS

SYMBOL	DEFINITION	UNITS
A	Altitude	Feet
V	Velocity	Knots
X	X acceleration N_x	g's
Y	Y acceleration N_y	g's
Z	Z acceleration N_z	g's
P	Roll	Degrees per sec.
Q	Pitch	" " "
R	Yaw	" " "
Time	Time	1/30 second
I	Two or more of the above listed data points falling in the same band	

II. EXPLANATION AND INTERPRETATION OF THE DATA

Table 2 gives a listing of the 9-track computer tapes and their contents. These contents are data files which were created by compressing the raw data from the in-flight recorder magazines. This raw data was condensed by using a computer program written by FIBG (Structural Vibration Branch) WPAFB, Ohio. Table 2 goes on to note which of the tapes listed are usable and to what extent they are usable.

A particular raw data tape is one magazine from one in-flight recorder. This raw data tape then comprises one file on the condensed data tape. Each file is a monitoring of one aircraft for the length of time that the in-flight recorder was in use on this aircraft, so each file may contain many flights.

The computer program LCOMP, written by FIBG, was used to scan each compressed data tape and print output tables with one of the following options:

(1) A tabular listing of altitude, airspeed, accelerations in the x, y, and z directions, roll pitch, yaw and time.

(2) A graphical representation of the above parameters.

(3) Both a tabular and graphical representation of the above parameters, as shown in Table 3.

The computer program LCOMP scans each data tape and prints the following output in order:

(1) Identification data - data used to identify the aircraft, base, etc.

(2) Engineering units - this is a table of values which creates 64 bands for each parameter (altitude, airspeed, acceleration in x, y, and z directions, roll, pitch, yaw, and time.)

(3) Output selection by option:
  (a) A tabular listing of each parameter.
  (b) A graphical representation of each parameter
  (c) Both tabular listing and a graphical representation of each parameter.

TABLE 2

LISTING OF TAPES

TAPE NO.	CONTENTS	USABILITY (If Bad; Reason Bad)
X01061	11 Files	All Files Usable
X02560	6 Files	All Files Usable
X00185	6 Files	5 Files Good (Bad file due to incomplete file)
X02980	9 Files	All Files Good
X03327	9 Files	All Files But 2 Good (2 files only partial)
X03499	8 Files	All Files Bad (Data very inconsistant)
X04143	8 Files	All Files Bad (Tape unable to be read without parity errors)
X00872	7 Files	All Files Bad (Data inconsistant)

TABLE 3. TYPICAL LCOMP OUTPUT

```
A= 14V= 14Z= 35Y= 33X= 30P= 32Q= 32R= 29TIME=   103916        I                       RX IY Z
A= 14V= 13Z= 34Y= 33X= 30P= 32Q= 32R= 29TIME=   103918       VA                       RX IYZ
A= 14V= 14Z= 34Y= 33X= 30P= 32Q= 32R= 29TIME=   103919        I                       RX IYZ
A= 14V= 13Z= 33Y= 33X= 30P= 32Q= 32R= 29TIME=   103921       VA                       RX II
A= 14V= 14Z= 34Y= 33X= 30P= 32Q= 36R= 29TIME=   103922        I                       RX PYZ  Q
A= 14V= 14Z= 33Y= 33X= 30P= 32Q= 32R= 29TIME=   103923        I                       RX II
A= 14V= 13Z= 33Y= 33X= 30P= 32Q= 32R= 29TIME=   103924       VA                       RX II
A= 14V= 14Z= 33Y= 33X= 30P= 32Q= 36R= 29TIME=   103925        I                       RX PI   Q
A= 14V= 13Z= 33Y= 33X= 30P= 32Q= 32R= 29TIME=   103927       VA                       RX II
A= 14V= 14Z= 33Y= 33X= 30P= 32Q= 32R= 29TIME=   103928        I                       RX II
A= 16V= 14Z= 33Y= 33X= 30P= 32Q= 32R= 29TIME=   103929        V A                     RX II
A= 16V= 13Z= 32Y= 33X= 30P= 32Q= 32R= 29TIME=   103930       V  A                     RX IY
A= 16V= 14Z= 32Y= 33X= 30P= 32Q= 32R= 29TIME=   103931        V A                     RX IY
A= 16V= 13Z= 31Y= 33X= 30P= 32Q= 32R= 29TIME=   103933       V  A                     RXZIY
A= 22V= 14Z= 32Y= 33X= 30P= 32Q= 32R= 29TIME=   103934        V       A               RX IY
A= 22V= 14Z= 31Y= 33X= 30P= 32Q= 32R= 29TIME=   103935        V       A               RXZIY
A= 22V= 13Z= 31Y= 33X= 30P= 32Q= 32R= 29TIME=   103936       V        A               RXZIY
A= 18V= 14Z= 31Y= 33X= 30P= 32Q= 32R= 29TIME=   103937        V   A                   RXZIY
A=  8V= 14Z= 31Y= 33X= 30P= 32Q= 36R= 33TIME=   103964   A    V                        XZPI   Q
A=  8V= 14Z= 31Y= 33X= 30P= 32Q= 37R= 33TIME=   103965   A    V                        XZPI    Q
A=  8V= 13Z= 31Y= 33X= 30P= 32Q= 37R= 33TIME=   103966   A   V                         XZPI    Q
A=  8V= 14Z= 32Y= 33X= 30P= 32Q= 37R= 33TIME=   103967   A    V                        X II    Q
A=  8V= 13Z= 31Y= 33X= 30P= 32Q= 37R= 33TIME=   103969   A   V                         XZPI    Q
A=  8V= 14Z= 32Y= 33X= 30P= 32Q= 37R= 33TIME=   103970   A    V                        X II    Q
A=  8V= 14Z= 33Y= 33X= 30P= 32Q= 37R= 33TIME=   103971   A    V                        X PI    Q
A=  8V= 13Z= 33Y= 33X= 30P= 32Q= 37R= 33TIME=   103972   A   V                         X PI    Q
A=  8V= 14Z= 33Y= 33X= 30P= 32Q= 37R= 33TIME=   103973   A    V                        X PI    Q
A=  8V= 14Z= 34Y= 33X= 30P= 32Q= 37R= 33TIME=   103974   A    V                        X PIZ   Q
A=  8V= 13Z= 33Y= 33X= 30P= 32Q= 37R= 33TIME=   103975   A   V                         X PI    Q
A=  8V= 14Z= 34Y= 33X= 30P= 32Q= 37R= 33TIME=   103976   A    V                        X PIZ   Q
A=  8V= 13Z= 34Y= 33X= 30P= 32Q= 38R= 33TIME=   103978   A   V                         X PIZ    Q
A=  8V= 14Z= 34Y= 33X= 30P= 32Q= 38R= 33TIME=   103979   A    V                       -X-PIZ    Q
A=  8V= 14Z= 35Y= 33X= 30P= 32Q= 38R= 33TIME=   103980   A    V                        X PI  Z  Q
A=  8V= 14Z= 36Y= 33X= 30P= 32Q= 38R= 33TIME=   103983   A    V                        X PI   Z Q
A= 10V= 14Z= 36Y= 33X= 30P= 32Q= 38R= 33TIME=   103985     A   V                       X PI   Z Q
A= 10V= 14Z= 37Y= 33X= 30P= 32Q= 38R= 33TIME=   103986     A   V                       X PI    ZQ
A= 10V= 14Z= 36Y= 33X= 30P= 32Q= 38R= 33TIME=   103987     A   V                       X PI   Z Q
A= 10V= 14Z= 37Y= 33X= 30P= 32Q= 38R= 33TIME=   103988     A   V                       X PI    ZQ
A= 12V= 14Z= 38Y= 33X= 30P= 32Q= 38R= 33TIME=   103991       A V                       X PI      I
A= 12V= 14Z= 39Y= 33X= 30P= 32Q= 39R= 33TIME=   103995       A V                       X PI       I
A= 10V= 14Z= 38Y= 33X= 30P= 32Q= 39R= 33TIME=   103996     A   V                       X PI      ZQ
A= 10V= 14Z= 39Y= 33X= 30P= 32Q= 39R= 33TIME=   103997     A   V                       X PI       I
A= 10V= 14Z= 40Y= 33X= 30P= 32Q= 39R= 33TIME=   103998     A   V                       X PI       QZ
A= 10V= 14Z= 39Y= 33X= 30P= 32Q= 39R= 33TIME=   103999     A   V                       X PI       I
A= 10V= 14Z= 40Y= 33X= 30P= 32Q= 40R= 33TIME=   104000     A   V                       X PI        I
A= 10V= 14Z= 41Y= 33X= 30P= 32Q= 40R= 33TIME=   104001     A   V                       X PI        QZ
A= 10V= 14Z= 42Y= 33X= 30P= 32Q= 40R= 33TIME=   104003     A   V                       X PI        Q Z
A= 10V= 14Z= 43Y= 33X= 30P= 32Q= 40R= 33TIME=   104006     A   V                       X PI        Q  Z
A= 10V= 14Z= 43Y= 33X= 30P= 32Q= 39R= 33TIME=   104008     A   V                       X PI       Q   Z
A= 10V= 14Z= 44Y= 33X= 30P= 32Q= 39R= 33TIME=   104013     A   V                       X PI       Q    Z
A= 10V= 14Z= 43Y= 33X= 30P= 32Q= 39R= 33TIME=   104014     A   V                       X PI       Q   Z
A= 10V= 14Z= 44Y= 33X= 30P= 32Q= 39R= 33TIME=   104015     A   V                       X PI       Q    Z
A=  8V= 14Z= 44Y= 33X= 30P= 32Q= 39R= 33TIME=   104016   A     V                       X PI       Q    Z
A=  8V= 14Z= 43Y= 33X= 30P= 32Q= 39R= 33TIME=   104020   A     V                       X PI       Q   Z
A=  8V= 14Z= 42Y= 24X= 30P= 32Q= 39R= 33TIME=   104023   A     V                      YX PR       Q  Z
A=  8V= 14Z= 42Y= 33X= 30P= 32Q= 39R= 33TIME=   104024   A     V                       X PI       Q  Z
A=  8V= 14Z= 43Y= 33X= 30P= 32Q= 39R= 33TIME=   104025   A     V                       X PI       Q   Z
A=  8V= 14Z= 43Y= 33X= 30P= 32Q= 38R= 33TIME=   104026   A     V                       X PI      Q    Z
A=  8V= 14Z= 44Y= 33X= 30P= 32Q= 38R= 33TIME=   104030   A     V                       X PI      Q     Z
A=  8V= 14Z= 45Y= 33X= 30P= 32Q= 38R= 33TIME=   104033   A     V                       X PI      Q       Z
```

The identification data presents information concerning aircraft tail number, squadron, base, number of flights, aircraft gross weight at takeoff, and recorder magazine number. This data is used to identify the aircraft from which the data came. Calibration data is also included as shown in Table 4. This is used in the calculations of flight times and for the creation of the 64 bands for each parameter, i.e., airspeed, time, altitude, etc. The remainder of the data would primarily be beneficial to the maintenance crew for that specific aircraft.

The next output from LCOMP is shown in Table 5. This output shows the specific value for each parameter in each band; e.g., average altitude is 424.93 ft. in Band 1, and 856.58 ft. in Band 2. The parameters are defined in Table 1, with the exception of PA, atmospheric pressure, and QC, dynamic pressure, both in inches of mercury. All units in Table 5 are shown times 1000 except for altitude and velocity. For example, PA = 20920 is actually 20.920 in. of mercury. Altitude (ALT) is in units of feet, and velocity (VCAL) is in units of knots. The column labeled COUNTS is actually the band number, varying from 0 to 63. This number corresponds to the number shown on the tabular portion of the output (see Table 3) and positions the parameter's appropriate symbol in the appropriate position in the graphical output to the right, as shown in Table 3.

The last portion of output from the program LCOMP is the tabular and graphical representation of the data. All symbols are shown and explained in Tables 1 and 5, with a typical example of output in Table 3. Table 3 shows the option of both tabular and graphical representation of the data. The first 8 columns (tabular chart) list the band that each of the eight parameters falls into. The ninth column is the time represented in 1/30's of a second. The 64 columns following

TABLE 4

IDENTIFICATION DATA

```
FILE=    1
  TAIL1 SQD BASE  MAG REC ACL GYR PTX DAT/IN DAT/OUT TAPE 11 PART LOGFLTS A/CHRS1 A/CHRS2 ERCT1 TAPE12 ERCT2 D.S.1 EXTRA
 626214 355    1   16  13   2   1   2 120177  260177   2367    1       10   17898   18064     2   2396     1    36     0
FLT1 BASE TO TIME1DATE  TOGW BASE LDTIME1DATE LDGW MISS REFUEL/WT/TIM/TIM CHRT/TIME CHRT/TIME CHRT/TIME
  1    1   838   1401 28852    1  1000  1401 21852 60 0     0     0     0     0    0     0     0     0    0
  2    1  1525   1401 29334    1  1725  1401 22086 20 0     0     0     0    48 1700     0     0     0    0
  3    1  1013   1801 29339    1  1151  1801 22086 20 0     0     0     0    48 1100     0     0     0    0
  4    1  1525   1801 29557    1  1700  1801 22069 20 0     0     0     0   286 1625     0     0     0    0
  5    1   820   2001 28752    1  1020  2001 22452 30 0     0     0     0     0    0     0     0     0    0
  6    1  1540   2001 26152    1  1716  2001 23652 30 0     0     0     0     0    0     0     0     0    0
  7    1  1535   2101 29884    1  1715  2101 22138 20 0     0     0     0   296 1630     0     0     0    0
  8    1  1405   2401 28752    1  1610  2401 21652 40 0     0     0     0     0    0     0     0     0    0
  9    1  1002   2501 27952    1  1216  2501 21852 40 0     0     0     0     0    0     0     0     0    0
 10    1   910   2601 26834    1  1050  2601 21946 20 0     0     0     0   288 1015     0     0     0    0
 82  120    98     95   120   98   100   125   134100 0     0     0     0     0    0     0     0     0 1072
CALIBRATION DATA
  -458   671    196     68   -56 11249  1893  196600 29920    857 -3125 -2296  1755-361280 -60364 -6213100
```

TABLE 5. ENGINEERING UNITS OF EACH DATA BAND

ENGINEERING UNITSX1000 FOR FILE NO. 1

COUNTS	PA(INHG)	QC(INHG)	NZ(G,S)	NY(G,S)	NX(G,S)	P(DEG/SEC)	Q(DEG/SEC)	R(DEG/SEC)	ALT(FT)	VCAL(KNOTS)
0	29920	857	-3125	-2296	1755	-361280	-60384	-62131	-1.33	133.12
1	29462	1528	-2929	-2228	1697	-350031	-58491	-60225	424.93	177.07
2	29004	2199	-2733	-2160	1639	-338782	-56598	-58319	856.58	211.61
3	28546	2870	-2537	-2092	1581	-327533	-54705	-56413	1293.79	240.84
4	28088	3541	-2341	-2024	1523	-316284	-52812	-54507	1736.72	266.53
5	27630	4212	-2145	-1956	1465	-305035	-50919	-52601	2185.53	289.63
6	27172	4883	-1949	-1888	1407	-293786	-49026	-50695	2640.41	310.74
7	26714	5554	-1753	-1820	1349	-282537	-47133	-48789	3101.54	330.23
8	26256	6225	-1557	-1752	1291	-271288	-45240	-46883	3569.12	348.40
9	25798	6896	-1361	-1684	1233	-260039	-43347	-44977	4043.35	365.44
10	25340	7567	-1165	-1616	1175	-248790	-41454	-43071	4524.44	381.52
11	24882	8238	-969	-1548	1117	-237541	-39561	-41165	5012.63	396.76
12	24424	8909	-773	-1480	1059	-226292	-37668	-39259	5508.15	411.25
13	23966	9580	-577	-1412	1001	-215043	-35775	-37353	6011.25	425.07
14	23508	10251	-381	-1344	943	-203794	-33882	-35447	6522.20	438.31
15	23050	10922	-185	-1276	885	-192545	-31989	-33541	7041.28	451.00
16	22592	11593	11	-1208	827	-181296	-30096	-31635	7568.77	463.21
17	22134	12264	207	-1140	769	-170047	-28203	-29729	8105.00	474.97
18	21676	12935	403	-1072	711	-158798	-26310	-27623	8650.29	486.31
19	21218	13606	599	-1004	653	-147549	-24417	-25917	9204.96	497.27
20	20760	14277	795	-936	595	-136300	-22524	-24011	9769.46	507.89
21	20302	14948	991	-868	537	-125051	-20631	-22105	10344.12	518.17
22	19844	15619	1187	-800	479	-113802	-18738	-20199	10929.37	528.15
23	19386	16290	1383	-732	421	-102553	-16845	-18293	11525.66	537.84
24	18928	16961	1579	-664	363	-91304	-14952	-16387	12133.47	547.26
25	18470	17632	1775	-596	305	-80055	-13059	-14481	12753.31	556.43
26	18012	18303	1971	-528	247	-68806	-11166	-12575	13385.72	565.36
27	17554	18974	2167	-460	189	-57557	-9273	-10669	14031.30	574.06
28	17096	19645	2363	-392	131	-46308	-7380	-8763	14690.65	582.55
29	16638	20316	2559	-324	73	-35059	-5487	-6857	15364.47	590.84
30	16180	20987	2755	-256	15	-23810	-3594	-4951	16053.48	598.94
31	15722	21658	2951	-188	-43	-12561	-1701	-3045	16758.47	606.86
32	15264	22329	3147	-120	-101	-1312	192	-1139	17480.29	614.00
33	14806	23000	3343	-52	-159	9937	2085	767	18219.86	622.17
34	14348	23671	3539	16	-217	21186	3978	2673	18976.20	629.59
35	13890	24342	3735	84	-275	32435	5871	4579	19756.40	636.86
36	13432	25013	3931	152	-333	43684	7764	6485	20555.66	643.98
37	12974	25684	4127	220	-391	54933	9657	8391	21377.31	650.96
38	12516	26355	4323	288	-449	66182	11550	10297	22222.78	657.81
39	12058	27026	4519	356	-507	77431	13443	12203	23093.69	664.55
40	11600	27697	4715	424	-565	88680	15336	14109	23991.82	671.15
41	11142	28368	4911	492	-623	99929	17229	16015	24919.13	677.64
42	10684	29039	5107	560	-681	111178	19122	17921	25877.64	684.03
43	10226	29710	5303	628	-739	122427	21015	19827	26870.43	690.31
44	9768	30381	5499	696	-797	133676	22908	21733	27899.69	696.51
45	9310	31052	5695	764	-855	144925	24801	23639	28968.80	702.61
46	8852	31723	5891	832	-913	156174	26694	25545	30081.39	708.64
47	8394	32394	6087	900	-971	167423	28587	27451	31241.61	714.58
48	7936	33065	6283	968	-1029	178672	30480	29357	32454.27	720.45
49	7478	33736	6479	1036	-1087	189921	32373	31263	33725.00	726.25
50	7020	34407	6675	1104	-1145	201170	34266	33169	35060.40	731.98
51	6562	35078	6871	1172	-1203	212419	36159	35075	36470.14	737.65
52	6104	35749	7067	1240	-1261	223668	38052	36981	37975.47	743.26
53	5646	36420	7263	1308	-1319	234917	39945	38887	39596.26	748.80
54	5188	37091	7459	1376	-1377	246166	41838	40793	41358.41	754.29
55	4730	37762	7655	1444	-1435	257415	43731	42699	43261.34	759.73
56	4272	38433	7851	1512	-1493	268664	45624	44605	45400.27	765.11
57	3814	39104	8047	1580	-1551	279913	47517	46511	47759.72	770.44
58	3356	39775	8243	1648	-1609	291162	49410	48417	50421.36	775.72
59	2898	40446	8439	1716	-1667	302411	51303	50323	53474.20	780.96
60	2440	41117	8635	1784	-1725	313660	53196	52229	57053.27	786.15
61	1982	41788	8831	1852	-1783	324909	55089	54135	61378.62	791.29
62	1524	42459	9027	1920	-1841	336158	56982	56041	66845.72	796.39
63	1066	43130	9223	1988	-1899	347407	58875	57947	74262.23	801.45

the tabular chart are a graphical representation of the same data, plotted with the parameter symbols shown in their band position. That is, altitude (A) = 6 and yaw (R) = 8 causes "A" to be printed in column 6, and "R" in column 8. The step increments used throughout the tabular or graphical output is based on time in 1/30's of a second. The output only prints when a specific item changes bands. All data not displayed between several time steps can be assumed to remain within the last band shown until the output is printed again. The values for the parameters can change between printed lines as long as the values remain within the bands and do not exceed a threshold value that will put them into the next band.

III. ANALYSIS OF THE DATA

Eight tapes containing 64 files with collected flight loads data from 84 magazines were examined. All of the compressed data was run through the program LCOMP and then viewed by hand to determine its true validity.

Some data was determined to be unreasonable for several reasons. A short list of examples follows:

(1) There should not be any altitude jumps in the graph for a short period of time. Altitude should usually only change one band in 1/30th of a second.

(2) Straight and level flight should yield very little variation in roll, pitch, and yaw.

(3) All data elements must be in the chart for the chart to be considered valid.

Tables 6 and 7 show typical examples of bad data. Table 6 shows a drastic jump in altitude from band 6 to band 62. During the short period of time involved (2/30 second), the altitude could not possibly jump from 3,100 feet to 66,845 feet. As a result, this section of data is not usable. N_x acceleration of the aircraft also shows a corresponding jump from band 30 to band 62. This jump in data appears to be caused by a transient voltage as the recorder is being shut down and then turned on again approximately three minutes later. From this point on, N_x remains in band 62, indicating that the aircraft is decelerating at a constant 1.841 g. The remaining channels of data appear constant and can be assumed to represent valid data, except for N_z. Additional analysis shows N_z to vary from band 31 to band 62, representing a vertical acceleration ranging from 2.755 g to 9.027 g, typically averaging around 4.0 g. Since altitude remains in band 6, representing 2,640 feet, these values of N_z do not appear valid and this entire section of data must be discarded.

TABLE 6. EXAMPLE OF ERRONEOUS DATA

```
A=  6V=  11Z= 36Y= 33X= 30P= 32U= 36R= 33TIME=   104275   A     V                X PI    I
A=  6V=  12Z= 39Y= 33X= 30P= 32U= 38R= 33TIME=   104276   A       V              X PI    QZ
A=  6V=  11Z= 39Y= 33X= 30P= 32U= 38R= 33TIME=   104278   A      V               X PI    QZ
A=  6V=  12Z= 40Y= 33X= 30P= 32U= 38R= 33TIME=   104279   A        V             X PI    Q Z
A= 62V=  32Z= 62Y= 33X= 62P= 62U= 62R= 33TIME=   104281                            VI                 I
A= 62V=  11Z= 62Y= 33X= 62P= 32U= 32R= 33TIME=   108901         V                  II                 I
A=  6V=  10Z= 31Y= 33X= 62P= 32U= 38R= 33TIME=   109267   A    V                  ZPI    Q            X
A=  6V=  10Z= 32Y= 33X= 62P= 32U= 38R= 33TIME=   109270   A    V                   II    Q            X
A=  6V=  10Z= 33Y= 33X= 62P= 32U= 38R= 33TIME=   109273   A    V                   PI    Q            X
A=  6V=  10Z= 33Y= 33X= 62P= 32U= 39R= 33TIME=   109274   A    V                   PI     Q           X
A=  6V=  10Z= 34Y= 33X= 62P= 32U= 39R= 33TIME=   109276   A    V                   PIZ    Q           X
A=  6V=  10Z= 35Y= 33X= 62P= 32U= 39R= 33TIME=   109279   A    V                   PI Z   Q           X
A=  6V=  10Z= 35Y= 33X= 62P= 32U= 40R= 33TIME=   109280   A    V                   PI Z    Q          X
A=  6V=  10Z= 36Y= 33X= 62P= 32U= 40R= 33TIME=   109282   A    V                   PI  Z   Q          X
A=  6V=  10Z= 37Y= 33X= 62P= 32U= 41R= 33TIME=   109284   A    V                   PI   Z   Q         X
A=  6V=  10Z= 38Y= 33X= 62P= 32U= 41R= 33TIME=   109286   A    V                   PI    Z Q          X
A=  6V=   9Z= 36Y= 33X= 62P= 32U= 41R= 33TIME=   109288   A  V                     PI    Z Q          X
A=  6V=   9Z= 39Y= 33X= 62P= 32U= 41R= 33TIME=   109289   A  V                     PI     Z Q         X
A=  6V=   9Z= 39Y= 33X= 62P= 32U= 40R= 33TIME=   109290   A  V                     PI     ZQ          X
A=  6V=   9Z= 39Y= 33X= 62P= 32U= 39R= 33TIME=   109294   A  V                     PI     I           X
A=  6V=   9Z= 39Y= 33X= 62P= 32U= 38R= 33TIME=   109299   A  V                     PI    QZ           X
A=  6V=   9Z= 36Y= 33X= 62P= 32U= 38R= 33TIME=   109304   A  V                     PI    I            X
A=  6V=   9Z= 38Y= 33X= 62P= 32U= 39R= 33TIME=   109305   A  V                     PI    ZQ           X
A=  6V=   9Z= 39Y= 33X= 62P= 32U= 39R= 33TIME=   109310   A  V                     PI     I           X
A=  6V=   9Z= 39Y= 33X= 62P= 32U= 40R= 33TIME=   109311   A  V                     PI      ZQ         X
A=  6V=   9Z= 39Y= 33X= 62P= 32U= 39R= 33TIME=   109316   A  V                     PI      I          X
A=  6V=   8Z= 39Y= 33X= 62P= 32U= 39R= 33TIME=   109321   A V                      PI      I          X
A=  6V=   9Z= 39Y= 33X= 62P= 32U= 39R= 33TIME=   109322   A  V                     PI      I          X
A=  6V=   9Z= 39Y= 38X= 62P= 32U= 39R= 33TIME=   109323   A  V                     PR     YI          X
A=  6V=   8Z= 39Y= 38X= 62P= 32U= 39R= 33TIME=   109324   A V                      PR     YI          X
A=  6V=   8Z= 39Y= 38X= 62P= 32U= 38R= 33TIME=   109325   A V                      PR     IZ          X
A=  6V=   8Z= 38Y= 33X= 62P= 32U= 38R= 33TIME=   109328   A V                      PI     I           X
A=  6V=   8Z= 36Y= 33X= 62P= 32U= 39R= 33TIME=   109337   A V                      PI     ZQ          X
A=  6V=   8Z= 39Y= 33X= 62P= 32U= 39R= 33TIME=   109341   A V                      PI      I          X
A=  6V=   8Z= 36Y= 33X= 62P= 32Q# 39R= 33TIME=   109342   A V                      PI     ZQ          X
A=  6V=   8Z= 36Y= 33X= 62P= 32U= 38R= 33TIME=   109346   A V                      PI     I           X
A=  6V=   8Z= 39Y= 33X= 62P= 32U= 38R= 33TIME=   109354   A V                      PI     QZ          X
A=  6V=   8Z= 38Y= 33X= 62P= 32U= 38R= 33TIME=   109355   A V                      PI     I           X
A=  6V=   8Z= 39Y= 33X= 62P= 32U= 36R= 33TIME=   109356   A V                      PI     QZ          X
A=  6V=   8Z= 39Y= 33X= 62P= 32U= 39R= 33TIME=   109362   A V                      PI      I          X
A=  6V=   8Z= 36Y= 33X= 62P= 32U= 39R= 33TIME=   109364   A V                      PI     ZQ          X
A=  6V=   8Z= 39Y= 33X= 62P= 32U= 36R= 33TIME=   109365   A V                      PI     QZ          X
A=  6V=   8Z= 36Y= 33X= 62P= 32U= 38R= 33TIME=   109367   A V                      PI     I           X
A=  6V=   8Z= 39Y= 33X= 62P= 32U= 38R= 33TIME=   109369   A V                      PI     QZ          X
A=  6V=   8Z= 36Y= 33X= 62P= 32U= 36R= 33TIME=   109371   A V                      PI     I           X
A=  6V=   8Z= 38Y= 33X= 62P= 32U= 39R= 33TIME=   109372   A V                      PI     ZQ          X
A=  6V=   8Z= 37Y= 33X= 62P= 32U= 39R= 33TIME=   109375   A V                      PI    Z Q          X
A=  6V=   8Z= 36Y= 33X= 62P= 32U= 39R= 33TIME=   109378   A V                      PI     ZQ          X
A=  6V=   8Z= 39Y= 33X= 62P= 32U= 39R= 33TIME=   109379   A V                      PI      I          X
A=  6V=   8Z= 36Y= 33X= 62P= 32U= 39R= 33TIME=   109384   A V                      PI     ZQ          X
A=  6V=   8Z= 37Y= 33X= 62P= 32U= 38R= 33TIME=   109390   A V                      PI    ZQ           X
A=  6V=   8Z= 36Y= 33X= 62P= 32U= 38R= 33TIME=   109391   A V                      PI     I           X
A=  6V=   8Z= 39Y= 33X= 62P= 32U= 39R= 33TIME=   109392   A V                      PI      I          X
A=  6V=   8Z= 38Y= 33X= 62P= 32U= 36R= 33TIME=   109393   A V                      PI     I           X
A=  6V=   8Z= 39Y= 33X= 62P= 32U= 38R= 33TIME=   109395   A V                      PI     QZ          X
A=  6V=   8Z= 39Y= 33X= 62P= 32U= 39R= 33TIME=   109396   A V                      PI      I          X
A=  6V=   8Z= 38Y= 33X= 62P= 32U= 36R= 33TIME=   109399   A V                      PI     I           X
A=  6V=   8Z= 37Y= 33X= 62P= 32U= 38R= 33TIME=   109414   A V                      PI    ZQ           X
A=  6V=   8Z= 38Y= 33X= 62P= 32U= 36R= 33TIME=   109418   A V                      PI     I           X
A=  6V=   8Z= 37Y= 33X= 62P= 32U= 36R= 33TIME=   109419   A V                      PI    ZQ           X
```

TABLE 7. EXAMPLE OF ERRONEOUS DATA

A=	10V=	7Z=	35Y=	33X=	62P=	32U=	37K=	3311ME=	115774	V A	PI Z Q	X
A=	6V=	7Z=	34Y=	33X=	62P=	32U=	37K=	3311ME=	115777	VA	PIZ Q	X
A=	10V=	7Z=	35Y=	33X=	62P=	32U=	37K=	3311ME=	115778	V A	PI Z Q	X
A=	14V=	7Z=	35Y=	33X=	62P=	32U=	37K=	3311ME=	115781	V A	PI Z Q	X
A=	16V=	7Z=	35Y=	33X=	62P=	32U=	37K=	3311ME=	115782	V A	PI Z Q	X
A=	16V=	7Z=	34Y=	33X=	62P=	32U=	37K=	3311ME=	115786	V A	PIZ Q	X
A=	16V=	7Z=	35Y=	33X=	62P=	32U=	36K=	3311ME=	115787	V A	PI ZQ	X
A=	16V=	7Z=	35Y=	33X=	62P=	32U=	37K=	3311ME=	115788	V A	PI Z Q	X
A=	12V=	7Z=	34Y=	33X=	62P=	32U=	37K=	3311ME=	115789	V A	PIZ Q	X
A=	12V=	7Z=	35Y=	33X=	62P=	32U=	36K=	3311ME=	115790	V A	PI ZQ	X
A=	10V=	7Z=	35Y=	33X=	62P=	32U=	36K=	3311ME=	115791	V A	PI ZQ	X
A=	10V=	7Z=	34Y=	33X=	62P=	32U=	37K=	3311ME=	115792	V A	PIZ Q	X
A=	10V=	7Z=	34Y=	33X=	62P=	32U=	36K=	3311ME=	115794	V A	PIZ Q	X
A=	12V=	7Z=	34Y=	33X=	62P=	32U=	36K=	3311ME=	115795	V A	PIZ Q	X
A=	14V=	7Z=	35Y=	33X=	62P=	32U=	37K=	3311ME=	115796	V A	PI Z Q	X
A=	14V=	7Z=	35Y=	33X=	62P=	32U=	36K=	3311ML=	115797	V A	PI ZQ	X
A=	14V=	7Z=	36Y=	33X=	62P=	32U=	32K=	3311ME=	115799	V A	II Z	X
A=	14V=	7Z=	35Y=	33X=	62P=	32U=	32K=	3311ME=	115800	V A	II Z	X
A=	14V=	7Z=	34Y=	33X=	62P=	32U=	32K=	3311ME=	115801	V A	IIZ	X
A=	12V=	7Z=	32Y=	33X=	62P=	32U=	32K=	3311ML=	115804	V A	II	X
A=	6V=	8Z=	31Y=	33X=	62P=	32U=	37K=	3311ME=	115911	I	ZPI Q	X
A=	8V=	8Z=	31Y=	33X=	62P=	32U=	37K=	3311ML=	115913	I	ZPI Q	X
A=	8V=	7Z=	31Y=	33X=	62P=	32U=	37K=	3311ME=	115915	VA	ZPI Q	X
A=	8V=	8Z=	31Y=	33X=	62P=	32U=	37K=	3311ME=	115916	I	ZPI Q	X
A=	8V=	7Z=	31Y=	33X=	62P=	32U=	37K=	3311ME=	115918	VA	ZPI Q	X
A=	6V=	8Z=	32Y=	33X=	62P=	32U=	37K=	3311ML=	115919	I	II Q	X
A=	6V=	7Z=	31Y=	33X=	62P=	32U=	37K=	3311ME=	115921	AV	ZPI Q	X
A=	8V=	8Z=	32Y=	33X=	62P=	32U=	37K=	3311ME=	115922	I	II Q	X
A=	6V=	7Z=	32Y=	33X=	62P=	32U=	37K=	3311ME=	115923	VA	II Q	X
A=	8V=	8Z=	32Y=	33X=	62P=	32U=	37K=	3311ME=	115925	I	II Q	X
A=	8V=	7Z=	32Y=	33X=	62P=	32U=	37K=	3311ME=	115927	VA	II Q	X
A=	8V=	8Z=	32Y=	33X=	62P=	32U=	36K=	3311ME=	115928	I	II Q	X
A=	8V=	8Z=	32Y=	29X=	62P=	32U=	36K=	3311ML=	115929	I	Y IR Q	X
A=	8V=	7Z=	31Y=	28X=	62P=	32U=	36K=	3311ME=	115930	VA	Y ZPR Q	X
A=	10V=	8Z=	31Y=	28X=	62P=	32U=	36K=	3311ME=	115931	V A	Y ZPR Q	X
A=	10V=	8Z=	31Y=	28X=	62P=	32U=	32K=	3311ME=	115932	V A	Y ZIR	X
A=	10V=	7Z=	31Y=	27X=	62P=	32U=	32K=	3311ME=	115933	V A	Y ZIR	X
A=	10V=	8Z=	31Y=	-27X=	62P=	32U=	32K=	3311ME=	115934	V- A	Y -ZIR	X
A=	10V=	7Z=	31Y=	27X=	62P=	32U=	32K=	3311ME=	115935	V A	Y ZIR	X
A=	6V=	8Z=	31Y=	33X=	62P=	32U=	38K=	3311ME=	116296	A V	ZPI Q	X
A=	6V=	6Z=	32Y=	33X=	62P=	32U=	37K=	3311ME=	116302	A V	II Q	X
A=	6V=	8Z=	33Y=	33X=	62P=	32U=	36K=	3311ME=	116314	A V	PI Q	X
A=	6V=	6Z=	33Y=	33X=	62P=	32U=	32K=	3311ME=	116319	A V	II	X
A=	6V=	8Z=	32Y=	33X=	62P=	32U=	32K=	3311ML=	116320	A V	II	X
A=	6V=	7Z=	31Y=	33X=	62P=	32U=	32K=	3311ME=	116326	AV	ZII	X
A=	6V=	8Z=	32Y=	33X=	62P=	32U=	32K=	3311ML=	116327	A V	II	X
A=	6V=	7Z=	31Y=	33X=	62P=	32U=	32K=	3311ME=	116329	AV	ZII	X
A=	6V=	8Z=	31Y=	33X=	62P=	32U=	32K=	3311ML=	116330	A V	ZII	X
A=	18V=	8Z=	31Y=	33X=	62P=	32U=	36K=	3311ME=	116601	V A	ZPI Q	X
A=	18V=	8Z=	31Y=	33X=	62P=	32U=	32K=	3311ME=	116603	V A	ZII	X
A=	18V=	9Z=	31Y=	33X=	62P=	32U=	32K=	3311ME=	116604	V A	ZII	X
A=	10V=	9Z=	31Y=	33X=	62P=	32U=	36K=	3311ME=	116624	VA	ZPI Q	X
A=	10V=	9Z=	31Y=	33X=	62P=	32U=	36K=	3311ME=	116627	VA	ZPI Q	X
A=	10V=	9Z=	31Y=	33X=	62P=	32U=	32K=	3311ME=	116628	VA	ZII	X
A=	8V=	9Z=	31Y=	33X=	62P=	32U=	32K=	3311ME=	116630	AV	ZII	X
A=	6V=	9Z=	31Y=	33X=	62P=	32U=	36K=	3311ME=	116639	A V	ZPI Q	X
A=	6V=	9Z=	31Y=	33X=	62P=	32U=	32K=	3311ME=	116642	A V	ZII	X
A=	12V=	9Z=	31Y=	33X=	62P=	32U=	38K=	3311ME=	116678	V A	ZPI Q	X
A=	12V=	8Z=	31Y=	33X=	62P=	32U=	38K=	3311ME=	116680	V A	ZPI Q	X
A=	12V=	9Z=	32Y=	33X=	62P=	32U=	36K=	3311ME=	116681	V A	II Q	X

Table 7 shows a pattern of constantly changing altitude, which suggests that the aircraft is going through a maneuver. Careful examination of the data shows that the altitude changes by 1385 feet in 1/30th of a second, which is not possible; and again all of this data must be eliminated.

After analyzing all the 9-track compressed data tapes it was determined that the earlier test flights yielded the best data. During later flights, many channels of output data were found unusable. Instrumentation errors along with flight recorder upkeep were apparently the cause for this unusable data. The first channel of data to deteriorate was altitude, and this is the most serious loss of data.

Despite the amount of invalid data, the data tapes appear to contain sufficient usable A-7D flight loads data so that data reduced in this effort will reflect A-7D usage accurately.

A primary difficulty to be encountered when reviewing all data tapes is that the calibration data varies from recorder to recorder. Deciding upon a common set of bands for each parameter is necessary to consolidate the data into a large file of usable information.

Histograms of time in bands for vertical load factors, altitude, and airspeed can be prepared and exceedance curves of load factors and roll rates can be established. Meaningful correlation tables of the various parameters are possible as shown in Table 8. However, because of the loss of some of the data, particularly altitude, there is insufficient data to produce some of the correlations. The most important correlations or cross-correlations are usually N_z with other parameters that affect calculations of aircraft loads. For example, simultaneous peaking of N_z and roll create asymmetric wing loading. Other correlations are possible, but probably not as meaningful.

A great deal of manual analysis and interpretation will be required to eliminate faulty data, in order to insure that the data used in the analysis is valid.

TABLE 8

MATRIX OF POSSIBLE MEANINGFUL CORRELATIONS

PEAKING PARAMETER	CORRELATIONS				
N_z	$N_z \cdot N_y$	$N_z \cdot Q$	$N_z \cdot P$	$N_z \cdot R$	$N_z \cdot A \cdot V$
N_y	$N_y \cdot N_z$	$N_y \cdot Q$	$N_y \cdot P$	$N_y \cdot R$	$N_y \cdot A$
PITCH (Q)	$Q \cdot N_z$	$Q \cdot N_y$	$Q \cdot A$		
ROLL (P)	$P \cdot N_z$	$P \cdot N_y$	$P \cdot A$		
YAW (R)	$R \cdot N_z$	$R \cdot N_y$	$R \cdot A$		